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# ODONTOSCHISMA MACOUNII AND ITS NORTH AMERICAN ALLIES.

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(WITH PLATES XVIII–XX)

## HISTORICAL.

AMONG the hepaticae recently collected by Professor John Macoun in the Yukon Territory are several fruiting specimens of *Odontoschisma Macounii*, a species confined to the higher latitudes and hitherto known in sterile condition only. The species has had a rather varied history. It was first described by Austin,[1] in 1872, as *Sphagnoecetis Macounii*, the original specimens having been collected in the Lake Superior region of Ontario in 1869. A portion of this original material has been kindly furnished me by Professor Macoun, but unfortunately it does not appear to be altogether homogeneous. Some of the specimens are gemmiparous and are pale green in color, while others are without gemmae and are more or less tinged with yellow or brown. It is evident that Austin's description is drawn almost entirely from the pale specimens, which may therefore be regarded as the type of the species. It is very probable also that the darker specimens are not specifically distinct from the others, and that their coloration is due simply to exposure to the sun. Nevertheless, on account of their incomplete character, this question can hardly be settled definitely at present. *O. Macounii* is either mentioned or briefly described by Underwood,[2] by Pearson,[3] and by

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[1] Bull. Torrey Bot. Club 3 : 13. 1872.

[2] Bull. Illinois State Lab. Nat. Hist. 2 : 92. 1884. BOT. GAZ. 17 : 312. 1892.

[3] List of Canadian Hepaticae 10. 1890.

Macoun,[4] but there is apparently no printed record of its having been collected a second time.

In the writings of certain Scandinavian bryologists, however, are a few references to a small arctic hepatic which agrees closely with the pale type specimens of *O. Macounii* and which is doubtless referable to Austin's species. This plant was first collected by Berggren in 1868 at King Bay on the island of Spitzbergen, and was described by him in 1875 under the name *Sphagnoecetis communis* var. *tessellata*.[5] In a second paper, also published in 1875,[6] he recorded the plant from Disco Bay on the western coast of Greenland, where he had collected it five years previously. This time it appears as *Jungermannia tessellata*, showing that he was not altogether certain as to its systematic position. Under this latter name the Greenland specimens are mentioned by Lange and C. Jensen[7] in 1887, and by Underwood[8] in 1892. In 1898 Kaalaas[9] recorded the species from Norway; he recognized in it an Odontoschisma, but referred it, as Berggren orginally did, as a var. *tessellata* to *O. Sphagni*. In the same year C. Jensen[10] published excellent figures of the plant under the name *O. tessellatum*. The specimens from which his figures were drawn were collected by Hartz at Scoresby Sound, on the eastern coast of Greenland, well within the Arctic Circle. Herr Jensen has kindly sent me two East Greenland specimens of his *O. tessellatum*, which were collected by Dusén in 1899,[11] and I have also been able to study Norwegian specimens collected and communicated by Herr Jörgensen. These specimens have served for comparison with Austin's type of *O. Macounii*. Additional specimens from Yukon, collected by Williams, and from northern Minnesota, collected by Holzinger, have also been examined. It is clearly seen, therefore, that the geographical distribution of *O. Macounii* is much more extensive than the published records would seem to indicate.

[4] Cat. Canadian Plants 7:32. 1902.

[5] Kongl. Sv. Vet. Akad. Handl. $13^7$: 101. 1875.

[6] *L. c.* $13^8$: 43. 1875.

[7] Meddel. om Grønland 3:411. 1887.

[8] BOT. GAZ. 17:311. 1892.

[9] Vidensk. Skrift. I. $1898^9$: 14.

[10] Meddel. om Grønland 15:369. *f. 1–4.* 1898.

[11] *Cf.* C. JENSEN, Öfvers. k. Vetensk.-Akad. Förh. 57:797. 1900.

Closely related to *O. Macounii*, but differing from it in several important respects, is a peculiar Odontoschisma which was collected by Miss Gertrude Gibbs at Port Renfrew, Vancouver Island, in 1901. This species is apparently undescribed and may be designated *O. Gibbsiae* in honor of its discoverer. The specimens are without sexual organs, but show well developed gemmiparous branches.

Two other members of the genus, *O. denudatum* and *O. Sphagni*, have been recorded from North America, north of Mexico. Both of these species have long been known in Europe, and *O. denudatum* has been reported from Siberia and from Japan. The range of this species in North America extends from Greenland to Louisiana, with a doubtful extension into the tropics. According to printed reports, the range of *O. Sphagni* is even more extensive, but a comparison of authentic European material with American specimens which have been determined as *O. Sphagni* shows that the majority of the latter are really referable to *O. prostratum*, a species originally described from Jamaica. In fact, I have seen no specimens whatever of true *O. Sphagni* from the United States, although the species occurs in Canada. Mitten reports[12] *O. prostratum* from Bermuda, and says that it also occurs in Europe, but the latter statement does not appear to be confirmed by any other European writer. In addition to Jamaica, *O. prostratum* has been reported from several localities in tropical America.

A careful study of these five species makes it evident that certain of the generic characters commonly accepted for Odontoschisma do not apply to all of the species, and that the genus as a whole is about as closely related to the monotypic Anomoclada, of South America, as it is to Cephalozia, with which it is commonly associated.

Odontoschisma was first proposed by Dumortier, in 1831,[13] as a section of his genus Pleuroschisma. This included also, as sections, Lepidozia and Pleuroschismotypus, the latter being essentially the same as Bazzania. In 1835[14] he raised all three

[12] Challenger Rept. Botany $1^2$ : 92. 1884.

[13] Syll. Jung. 68. 1831.

[14] Recueil d'Obs. sur les Jung. 19. 1835.

sections to generic rank, the section Pleuroschismotypus becoming the genus Pleuroschisma in its restricted sense. Two species of Odontoschisma, *O. Sphagni* and *O. denudatum*, are recognized. In the Synopsis Hepaticarum Nees von Esenbeck[15] redescribed the genus under the name Sphagnoecetis. He recognized but a single European species, *S. communis*, which was made to include both of Dumortier's species. Two exotic species, however, are doubtfully referred to the genus, and three other exotic species are added in the appendix.

In 1874 Lindberg[16] revised the European species of Odontoschisma and clearly distinguished between *O. Sphagni* and *O. denudatum*. Unfortunately he included in the genus *Jungermannia decipiens* Hook., a species which Mitten had placed in his genus Adelanthus[17] (now Adelocolea). In his paper on Anomoclada, published two years later, Spruce[18] showed clearly why Adelanthus should not be included in Odontoschisma. At the same time he fully described the two European species of the latter genus and ascribed to both a very wide geographical distribution, extending, in fact, into the tropics of South America. In 1877 Trevisan[19] accepted the genus Odontoschisma in Lindberg's wide sense, and included in it eleven species, most of them exotic.

In 1882 Spruce[20] reduced Odontoschisma to a subgenus under Cephalozia, on account of the close resemblance between their sexual branches and sporophytes, and he continued so to regard it during the remainder of his life. He was followed in this by Lindberg and by Arnell, as well as by Pearson and by several other hepaticologists of the English school. On the continent, however, and in America, this extreme view has never met with much favor, and Schiffner, in his treatment of the Hepaticae for Engler and Prantl's *Die natürlichen Pflanzenfamilien*, published in 1893, restored Odontoschisma to generic rank. Schiffner estimates the number of species of Odontoschisma at thirteen, and very few additions have been made up to the present time.

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[15] G. L. & N. Syn. Hep. 148. 1845.

[16] Notis. ur Sällsk. pro F. et Fl. Fenn. Förhandl. 13:357. 1874.

[17] Jour. Linn. Soc. Bot. 7:244. 1864.

[18] Jour. Bot. 5:166. 1876.

[19] Mem. R. Ist. Lomb. III. 4:418. 1877.

[20] On Cephalozia 59. 1882.

### GENERIC CHARACTERS.

The generic characters ascribed by Schiffner to Odontoschisma are those accepted by the majority of recent writers, whether they regard the group as a genus or merely as a subgenus under Cephalozia. The most important of these characters are the following:

Plants rather large, growing in tufts, varying from green to red or dark brown; stems creeping, radicelliferous, not arising from a rhizome; branching uniformly postical; leaves succubous, entire, obliquely or longitudinally inserted, varying in outline from orbicular to ovate, rarely emarginate at the apex, cell walls thickened; underleaves small; ♀ inflorescence on a short branch; perianth hypogonianthous, dentate or ciliate at the contracted mouth; capsule oval.

All of these characters apply pretty definitely to *O. Sphagni* and also to *O. prostratum.* In our other species, however, the branching exhibits considerable variation, especially in *O. Macounii.* In this species, moreover, the mouth of the perianth is entire or nearly so, and the underleaves often attain a considerable size. Underleaves, in fact may be demonstrated in all our species, and although they are sometimes small and transitory in their nature, they afford nevertheless differential characters of considerable importance.

### BRANCHING.

The branching in Odontoschisma is always intercalary in character, using this term in the sense suggested by Leitgeb.[21] According to this author, intercalary branches arise almost invariably from the postical segments of an axis. This origin is seen very clearly in Kantia and in the typical species of Cephalozia. It is also seen in the flagella and in the sexual branches of Bazzania. In Odontoschisma the postical origin of the branches may be demonstrated in the normal flagella of all our species (*fig. 44*) and also in the vegetative and sexual branches of *O. Sphagni* and *O. prostratum* (*fig. 42*). In *O. Macounii*, however, the leafy branches and also the sexual

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[21] Unters. über Lebermoose 2:21. 1875.

branches are sometimes postical, sometimes lateral (*fig. 1*), and sometimes occupy a position between postical and lateral. In fact, the lateral position is the most frequent and is almost invariably assumed by the sexual branches. In *O. Gibbsiae* and in *O. denudatum*, as well as in the recently described *O. cavifolium* Steph.[22] of Japan, lateral branches are also of occasional occurrence. That the origin of these branches is really postical and their lateral position is due merely to displacement, as Leitgeb maintains is the case in Plagiochila, is not improbable, but it has not been determined with certainty. It is clear, however, that this theory of displacement from the postical segment cannot apply to the genus Anomoclada, where all the branches except the flagella are distinctly antical in position. In this genus it is perfectly apparent that the branches arise from the lateral segments, and the difference in position between such an antical branch and the lateral branches in *Odonotoschisma Macounii* is really not very great.

The lateral branching which occurs in *Cephalozia Turneri* and in some of its immediate allies was used by Spruce[23] as the essential character of his subgenus Prionolobus, a group which Schiffner has since raised to generic rank. On the same grounds *O. Macounii* might be separated generically from *O. Sphagni*, but such a separation would be very artificial, especially when we take into consideration the inconstancy in the position of the branches in *O. Macounii*. In fact, the generic claims of Prionolobus are not above criticism, on account of the occurrence of both postical and lateral branches in certain undisputed species of Cephalozia.

It is probable that the position occupied by intercalary branches, and especially by those of adventitious origin (*i. e.*, by those arising from differentiated axis-cells which have reassumed an embryonic character), is largely influenced by the conditions under which a species develops. This statement would apply especially to plastic species, of which *O. Macounii* seems to offer an example, but it would also apply to the plastic ancestors of forms in which the branching has now become constant. It is clear, for example, that in a species with prostrate stems the postical position of the flagella is of distinct advantage, because it enables these organs at once to penetrate the substratum and to act as fixing and absorbing organs. In a leafy branch, however, the advantages of a postical origin is not so clear. Except at the very beginning, when the branch needs protection from drying, it would be placed at a disadvantage, because it would have to grow out beyond the leaves of the axis before it could develop normally and expose its leaves to the light. In such a case a lateral displacement would enable it to perform its functions earlier, while an antical position would be most advantageous of all. The last, however, would be precarious, unless there were some provision for keeping the branch-rudiment moist; this is secured in Anomoclada by a copious secretion of slime. In sexual branches the postical position is at first of distinct advantage, because it protects the antheridia and archegonia from drying, and at the same time tends to insure fertilization. It continues to be of advantage in such genera as Kantia, where a subterranean sac is developed. But in most cases the female branch curves upward and the perianth shortly assumes a position at right angles to the substratum. In this way the young capsule is so placed that a simple elongation of its stalk will push it above the perianth and expose its ripened spores to currents of air. The latter advantage is, of course, more easily secured by lateral or antical branches. Lateral branching, on the whole, seems to be the most serviceable type. This is seen especially well in the large and very successful group of the Jubuloideae, where postical branching has entirely disappeared. In this group, to be sure, the branching is terminal, and the lateral branches are therefore laid down at the growing apex. There is little doubt, however, that in the ancestors of these forms the method of branching was less definite.

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[22] Bull. de l'Herb. Boissier 5 : 102. 1897.

[23] Hep. Amaz. et And. 508 (footnote). 1885.

## LEAF-CELLS.

The thickening of the cell wall has already been quoted as an important generic character of Odontoschisma, and the variations in the thickening afford excellent differential characters for the species. The thickening may be observed in the cells of the stems and branches, but is best studied in the leaves. Here it is most pronounced in the angles of the cells, where it forms distinct and often conspicuous trigones, but it affects the cuticle of the leaves as well. In this region the thickening is fairly uniform, and we sometimes find a uniform thickening also in the vertical walls of the marginal cells. Intermediate thickenings seem never to be present.

In *O. Macounii* the thickenings of the cell wall are especially pronounced, the trigones being extremely large, and the cuticle thickened in a corresponding degree (*figs. 5, 6*). The trigones, in fact, project far out into the cell cavities, which become in consequence distinctly stellate with narrow rays, the latter of course forming pits for communication between adjoining cells. It is often possible to recognize in a trigone a distinct line of demarcation separating the original trigone, as laid down in the developing leaf, from a secondary deposit. This line of demarcation is clearly brought out by treatment with sulfuric acid in the presence of iodin, which serves at the same time to demonstrate the presence of cellulose in the wall. The trigones of this species are especially likely to be confluent; in some cases this is true of the original trigones; in other cases the coalescence is brought about by the secondary deposit, which causes at the same time the obliteration of a pit. Much of the thickening of the cuticle is also due to the secondary deposit. The cells of the underleaves are sometimes rather thin-walled, and sometimes have thicker walls than the leaves themselves (*fig. 13*). The last is true also of the leaves on gemmiparous branches, of the perigonial and perichaetial bracts, and of the lower part of the perianth (*fig. 23*). In most of these regions there is a tendency for the cells to be arranged in longitudinal rows, and the excessive thickening brings about an extensive coalescence of trigones. These are commonly united in such a way that the pits connecting the cells laterally are filled up by the secondary deposit, while those connecting the cells longitudinally are retained. Through this process the lower part of the perianth becomes a series of flattened thick-walled tubes, which are continuous except for the thin partitions separating the cells of which they are composed. These tubes are bounded without and within by the thickened cuticle, and are separated from one another by the coalescent trigones. In the upper part of the perianth the cells are uniformly and only slightly thickened (*fig. 24*), and there is a gradual transition from these to the thick-walled cells just described. The thickenings of the cell walls, although found in all the specimens of *O. Macounii* examined, are especially pronounced in those from the far north.

If we confine our attention to the median leaf-cells, our five species of Odontoschisma will be found to exhibit a regular descending series with respect to their trigones. *O. Macounii* stands at the beginning of this series. In *O. Gibbsiae*, which comes next, the trigones are still large, and the cavities are stellate, but the pits are broader and the trigones are less frequently confluent (*fig. 31*). In this species the trigones rarely show a line of demarcation, except when the portion lining the cavity becomes pigmented, and they also fail to respond directly to the cellulose test. In *O. denudatum* the trigones are still pronounced, but the cavities are less distinctly stellate, the trigones not projecting far enough out into the cavities to leave narrow pits (*fig. 35*). In *O. Sphagni* the trigones are smaller and project only slightly into the cavities, which in consequence become rounded in outline (*fig. 39*). In *O. prostratum* the trigones are still less conspicuous and commonly turn a concave face toward the cavity, which acquires in this way a polygonal outline with rounded angles (*figs. 55, 56*).

Throughout the genus Odontoschisma the median leaf-cells, if we consider them bounded by their middle lamellae, are polygonal in outline and isodiametric. The marginal leaf-cells, however, are quadrate or rectangular in outline, and in the latter case the long axis of the cell is commonly at right angles to the margin. In most species the marginal cells are not very different from the median cells, except for this slight difference in shape. This is true of *O. Macounii*, *O. Gibbsiae*, and *O. denudatum* (*figs. 7, 32, 36*). In other species there are several successive rows of four-sided cells, forming a distinct border around a considerable portion of the leaf. This bordered appearance is often made more conspicuous by the involute character of the leaf margin. A border of this sort has long been emphasized as one of the most important characters separating *O. Sphagni* from *O. denudatum.* The border of *O. Sphagni* (*fig. 40*), however, is much less distinct than that of *O. prostratum* (*figs. 57, 58*). In both species we find two to four rows of marginal cells which exhibit a tendency, sometimes very clearly marked, to be arranged in radial rows as well. These marginal cells have uniformly thickened walls, giving them a very different appearance from the thin-walled median cells with their small trigones. In *O. prostratum* the leaves exhibit considerable variation, not only with respect to the width of the border, but also with respect to the thickness of the walls of the marginal cells, and the two extreme conditions represented in the figures are connected by a series of intermediate forms. Both in this species and in *O. Sphagni*, the border is indistinct in poorly developed individuals.

### UNDERLEAVES.

The underleaves of Odontoschisma present peculiarities which have been strangely overlooked by writers on the genus. In the specimens of *O. Macounii* from Greenland and Yukon, these underleaves are especially large and persistent even on sterile stems, although they are considerably smaller on Minnesota specimens of the same species. Their most remarkable feature is found in the slime-secreting papillae which are borne in large numbers on their margins. Similar papillae are found on the underleaves of our other species of Odontochisma, but they are usually shorter-lived than in *O. Macounii.*

Leitgeb and others have already called attention to the frequent occurrence of papillae in connection with the growing-points of the Hepaticae. In the Jungermanniaceae they seem to be almost constantly present, but are usually restricted to the postical segments cut off from the apical cell. Leitgeb designates these papillae as "primordial," and looks upon them as structures which the leafy hepatics have inherited from their thallose ancestors.[24] When the postical segment is cut off in

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[24] Unters. über Lebermoose 2:7 ff. 1875.

these leafy forms, it divides by a periclinal wall into an inner and an outer cell, of which the latter gives rise to the papillae. In some cases this outer cell forms a single papilla before dividing. This is true, for example, of *Cephalozia bicuspidata*, *Nardia hyalina*, and *N. scalaris*. In other cases the outer cell divides by anticlinal walls into two, three, or four cells, each of which gives rise to a papilla. In *Plagiochila asplenioides*, for example, two papillae are formed; in *Acromastigum integrifolium*,[25] three; and in *Bazzania trilobata*, four. In a few species without underleaves, such as *Radula complanata* and *Cololejeunea calcarea*, no primordial papillae are formed by the ventral segments; but, on the other hand, the mere presence of papillae by no means insures the development of underleaves. When the latter are to be formed the papillae elongate, cells are cut off from their bases, and these cells by irregular divisions, both longitudinal and transverse, give rise to the permanent cells of the underleaves. In some cases there are as many lobes or divisions to the underleaf as there are primordial papillae, but usually the portions developing from the different papillae coalesce throughout more or less of their extent, and in some cases this coalescence extends to the very apex of the underleaf, which becomes thereby truncate or rounded.

In all our species of Odontoschisma two primordial papillae are formed and are succeeded by well developed underleaves. In *O. Sphagni* these are unfortunately short-lived, and the species has been described as being without underleaves or as having them rare and minute. As a matter of fact, they are always easy to demonstrate both in this species and in *O. Gibbsiae* near the apex of a vegetative branch, and in our other species they can usually be detected in the older parts of a plant as well. With regard to their structure and development two types of underleaf may be recognized. The first is found in *O. prostratum* and *O. Sphagni*, the other in our remaining three species. In the first type, through a succession of transverse walls in the cells cut off at the base of the papillae, two rows of cells are formed, growth and division continuing for some time at the base of the underleaf. These two rows of cells separate slightly at their free ends, which are tipped with the papillae, but coalesce throughout the greater part of their length. In this way a linear underleaf is formed, slightly bifid at the apex. In *O. prostratum* (*figs. 59–62*) a few longitudinal (or oblique) divisions sometimes occur near the base, and in *O. Sphagni* (*fig. 41*) these divisions are more frequent. Through these longitudinal divisions an underleaf may acquire a subulate form, but it is always much longer than broad. In the second type of underleaf the development begins in the same way, but the order of cell division is much less regular, longitudinal divisions tending to set in very early. The adult underleaves in consequence vary greatly in form, being sometimes distinctly bifid and sometimes rounded or truncate at the apex. In many cases the breadth equals or exceeds the length. These variations affect the underleaves, whether they remain small, as in *O. Gibbsiae* (*figs. 33, 34*), *O. denudatum* (*figs. 37, 38*), and some forms of *O. Macounii* (*figs. 9, 11, 12*), or attain a considerable size, as in the other forms of this same species (*fig. 10*).

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[25] EVANS, Bull. Torr. Bot. Club 27: 100. *pl. 1.* 1900.

As the underleaves develop, some or all of their cells give rise to a series of slime-secreting papillae, similar in all respects to the primordial papillae. In a young underleaf these may be found in all stages of development. A papilla begins as an outgrowth from a cell and soon becomes swollen at its extremity. In most cases a wall is formed at the base of the papilla, cutting it off from the cell. In rare cases this wall is suppressed and the cell simply forms a part of the papilla. Usually the papillae are limited to the margin of an underleaf, but occasionally they grow out from the postical surface as well. This is frequently the case in *O. Sphagni*, where it may even be difficult to distinguish the permanent cells of the underleaf on account of the crowded papillae which cover them. In our other species one or two papillae may occasionally be found on the postical surface. In rather rare cases two papillae may grow out from a single cell. The later development of the papillae has been briefly described by Goebel[26] for *Calobryum Blumei*. A layer of cellulose is deposited within the cell-wall at the swollen extremity of the papilla. Between this layer and the original wall the secretion of slime appears and is set free by the rupture of the wall. In most cases the papillae are short-lived and soon shrivel away. Occasionally, however, there are very clear indications that they continue active for a considerable period. In *O. Macounii*, for example, pits may be demonstrated in the marginal cells of the underleaves, connecting them with the papillae (*fig. 13*), and these pits are especially striking in cases where the cell walls are strongly thickened.

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[26] Ann. Jard. Buitenzorg 9: 15. 1891.

In the case of *O. Macounii*, slime-papillae are not confined to the underleaves. They may also be found on the leaf-margins close to the postical base, on the margins of the perichaetial bracts and bracteoles (*figs. 14–22*), and on short hair-like paraphyllia which are sometimes developed in connection with the archegonia (*fig. 4*). Whenever they occur in any of these localities they appear to be fully as persistent as on the underleaves.

Leitgeb has briefly alluded to the fact that the underleaves of *Bazzania trilobata*, as well as those of certain other species, sometimes bear a few papillae in addition to those which he designates as primordial, but he neither figures nor describes them further.[27] He also calls attention to the occasional occurrence of similar papillae on leaf-margins in more or less indefinite positions. These he would distinguish from primordial papillae, because they develop from leaf-cells (or underleaf-cells) instead of directly from the segments cut off from the apical cell. Although this distinction may be of theoretical interest, it is really of little practical importance, because all the papillae, whatever their origin, have the same structure and functions.

## THE FEMALE BRANCH.

The female branch in Odontoschisma affords a generic character which has not been sufficiently emphasized by writers. This is a peculiar enlargement at the apex of the branch, just below the perianth. It becomes evident after an archegonium has been fertilized, and is doubtless to be looked upon as one of the secondary effects of fertilization. A longitudinal section through the female branch and young sporophyte of *O. Macounii* (*fig. 4*) shows this enlargement very clearly, and also shows how the bracts and perianth are inserted. The foot of the developing sporophyte together with a portion of the stalk penetrate into this enlargement, which is composed in large part of food-storing cells. The capsule and the remainder of the stalk are covered by the calyptra, at the base of which may be seen a few paraphyllia and unfertilized archegonia. In *O. Macounii* the enlargement is radial in structure, probably on account of the lateral attachment of the female branch. In such a species as *O. prostratum*, however, where the branches are very short and uniformly postical, the enlargement is not wholly symmetrical, but shows a slight bulging in the portion turned toward the substratum (*fig. 42*). In the related genus Adelocolea a very similar condition exists, and in certain species the bulging portion becomes more prominent and forms a bulbous base into which the foot of the erect young sporophyte forces its way. In the genus Marsupidium the extreme development of the enlargement is found in the form of a cylindrical perigynium, in which practically the whole of the sporophyte is imbedded.

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[27] Unters. über Lebermoose 2 : 10. 1875.

It has already been noted that in *O. Macounii* the mouth of the perianth is wholly destitute of distinct teeth (*fig. 24*), and it may be added that these are not invariably present in other species. On *O. prostratum*, for example, much of the perianth-mouth is scarcely crenulate (*fig. 63*), and it is only occasionally that a short tooth, one or two cells long, can be demonstrated. Even in *O. Sphagni* and in *O. denudatum*, the teeth are often reduced to slight crenulations. The fact that the perianth is irregularly lobed at the mouth and often deeply plicate makes it difficult to gain an accurate idea of the true conditions. The difficulty is increased by the withering of the upper part of the perianth and by its irregular laceration when the mature capsule is extruded.

## GEMMIPAROUS BRANCHES.

In distinguishing the different species of Odontoschisma, the gemmiparous branches often yield characters of importance. In

*O. Sphagni* and in *O. prostratum*, gemmae are apparently never produced, but they occur more or less frequently in our other species, and in *O. denudatum* they may be found even on fruiting individuals. In this species the gemmiparous branches are the upright continuations of prostrate branches, and the formation of the gemmae soon puts a stop to further elongation. The leaves and underleaves on these branches are scarcely distinguishable from each other; they are distant and strongly squarrose, and become smaller and smaller toward the apex of the branch. In *O. Gibbsiae* (*fig. 29*) and in *O. Macounii* the gemmiparous branches are prostrate or ascending, but they likewise show three ranks of leaves, the underleaves being distinguishable only by their position. In both these species the leaves are concave, loosely imbricated, and relatively longer than ordinary leaves. Sometimes a branch of this character attains a considerable length, but its growth is ultimately terminated by the formation of gemmae. In *O. Macounii* gemmiparous branches are much less frequent than in *O. Gibbsiae*. The gemmae themselves are similar in the different species. They are oval or spherical bodies and are composed ot two cells, or more rarely of a single cell. In *O. denudatum* they are thin-walled, while in our other two species (*fig. 28*) they are thick-walled. In the lower part of a gemmiparous branch the leaves bear gemmae on their margins and outer surfaces; in the upper part the rudimentary leaves and the stem-apex become wholly transformed into a mass of gemmae.

## COMPARISON OF THE GENERA ODONTOSCHISMA, ANOMOCLADA, AND CEPHALOZIA.

One of the most striking peculiarities of the genus Anomoclada, as described by Spruce, is the secretion by the underleaves of so much slime that it literally floods the entire plant. In the original paper on this genus[28] it was further stated that "the marginal and apical cells [of the underleaves] were continually swelling and discharging their protoplasm, adhering for awhile as empty bleached bladders, then falling away, for the succeeding cells to undergo the same process." Spruce also called attention to the

[28] Journal of Botany 5 : 130. 1876.

difficulty of finding a perfect underleaf. An examination of the specimens of *A. mucosa* which were distributed in *Hepaticae Spruceanae* shows that the secretion of slime is performed by club-shaped papillae, similar in all respects to those described for Odontoschisma, and that it is not necessarily accompanied by the destruction of cells. The only difference between the genera in this respect is a difference of degree, the underleaves of Anomoclada being larger and the papillae more numerous than in Odontoschisma. They arise not only from the margin of an underleaf, but also from the postical surface near the margin, and sometimes a cell is directly transformed into a papilla. The basal cells of the underleaves acquire thickened walls with distinct trigones, and persist indefinitely, even after the papillae have lost their protoplasm and withered away. According to Spruce, the underleaves are "late ovata in acumen subulamve brevem producta . . . . superiora vix unquam perfecta, sed e margine apiceque plus minus dissolutis, nunc irregulariter bifida, nunc quadrifida vel digitatim multifida." As a matter of fact, the underleaves are variously divided, even in the vicinity of the growing point, and this division is in no sense due to the development of slime-secreting papillae. There seems to be no good reason, therefore, for considering that they are primarily undivided.

The strong resemblance between the underleaves of Odontoschisma and Anomoclada indicates a close relationship between the genera. They resemble each other further in their prostrate stems with postical flagella, in their succubous undivided leaves, and in their thick-walled leaf-cells with distinct trigones. Even closer to Anomoclada than any of the species which have yet been noted, is *Odontoschisma Portoricense*, a West Indian species (*figs. 65–74*). At first sight this looks precisely like a poorly developed form of *A. mucosa*, largely from the fact that its leaves are commonly crispate near the postical base and slightly convex—peculiarities which none of the more northern forms of the genus show. In *O. Portoricense* the underleaves (*fig. 70*) are covered over with slime-papillae, and the perichaetial bracts are often slightly connate (*fig. 71*), the latter being a character emphasized for Anomoclada. The vegetative branches are occasionally lateral (*fig. 65*), but rarely recede very far from the postical base of the subtending leaf: so far as observed, the female branches are invariably postical. The only character of real importance which distinguishes Anomoclada from Odontoschisma is its antical branching. Whether this peculiarity by itself is sufficient to separate genera may well be questioned, especially when we take into account the great variability in the branching of Odontoschisma.

One of the connecting links between Odontoschisma and Cephalozia is *C. Francisci*, a rare species known from several localities in western Europe and recently detected in Maine.[29] It was, to a considerable extent, the existence of this species which influenced Spruce in including Odontoschisma among his subgenera of Cephalozia. *C. Francisci* is a true Cephalozia and has bifid leaves, but the lobes of the latter are commonly rounded or obtuse, instead of being sharp-pointed as is usual in the genus. Similar bifid leaves with rounded lobes are exceptionally found in *Odontoschisma Sphagni*, as Spruce has already noted, and they are not infrequent in *O. prostratum* (*fig. 43*). *C. Francisci* agrees with Odontoschisma further in its postical flagella, and in its irregularly bifid underleaves, the latter being built up on essentially the same plan as in *O. Sphagni* and bearing a very few secondary marginal papillae of short duration. The only characters which separate this species from Odontoschisma are its smaller size, its more delicate structure, and its regularly bifid leaves, not one of which can be regarded as of very great moment. In fact, the second of these differences is hardly worthy of mention, because the cell walls of *C. Francisci*, although thinner than is usual in Odontoschisma, are by no means wholly destitute of thickenings; these appear in the leaves as minute but distinct trigones, in the involucral leaves and perianths as more or less uniform thickenings tending to obliterate the trigones.

It will be seen, therefore, that although Odontoschisma represents a natural group of closely allied species, there is, on the one hand, a very vague line of demarcation between Odontoschisma and Anomoclada, and, on the other hand, a similarly vague line between Odontoschisma and Cephalozia. In a certain sense our species of Odontoschisma form part of a continuous series, whose extremes are *Anomoclada mucosa* and *Cephalozia Francisci*. If we recognize three distinct genera in this series, it is largely because the two extremes are so very diverse. In the large group of the Lejeuneae we find these conditions duplicated, many of the recognized genera being connected by intermediate species.

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[29] *Cf.* Miss C. C. Haynes, Torreya 3:41. 1903.

## DESCRIPTION OF SPECIES WITH NOTES ON GEOGRAPHICAL DISTRIBUTION.

Full descriptions of *O. Macounii*, *O. Gibbsiae*, and *O. prostratum* are appended. *O. Portoricense* is also described, although the present paper makes no pretense of revising the species of Odontoschisma found in the American tropics. For descriptions of *O. denudatum* and *O. Sphagni*, aside from the characters discussed in the preceding pages, reference may be made to the writings of Lindberg,[30] of Spruce,[31] and of Pearson.[32] For all five of our northern species the synonymy and geographical distribution are noted, and the following artificial key will aid in their identification:

1. Plants commonly growing on rotten logs or on banks, branches varying from postical to lateral, leaves more or less strongly concave, not margined, gemmiparous branches often abundant - - - - 2

1. Plants, commonly growing in bogs or swamps, branches always postical, leaves plane or slightly concave, more or less distinctly margined, gemmiparous branches wanting - - - - - - - 4

2. Leaves and underleaves on the gemmiparous branches suberect, strongly concave and imbricated - - - - - - - - - - 3

2. Leaves and underleaves on the gemmiparous branches squarrose, plane or slightly concave and distant - - - - - 3. *O. denudatum*

3. Plants pale green or yellowish, leaves not dilated at the postical base, median leaf-cells averaging 28 μ in diameter, underleaves distinct and frequently conspicuous - - - - - - - 1. *O. Macounii*

3. Plants varying from pale green to reddish or brownish, leaves dilated at the postical base, median leaf-cells averaging 19 μ in diameter, underleaves usually minute and inconspicuous - - - 2. *O. Gibbsiae*

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[30] Notis. ur Sällsk. pro F. et Fl. Fenn. Förhandl. **13**: 357–360. 1874.

[31] Journal of Botany **5**: 166, 193. 1876. On Cephalozia 60, 61. 1882.

[32] Hep. British Isles 171, 174. 1900.

4. Plants commonly brownish green, leaves broadly orbicular, usually erect and connivent antically, margin rarely more than one cell wide - - - - - - - - - - 4. *O. Sphagni*

4. Plants pale green, more rarely tinged with brownish, leaves varying from oblong to orbicular but usually longer than broad, mostly explanate, margin from one to four cells wide - - - 5. *O. prostratum*

1. ODONTOSCHISMA MACOUNII (Aust.) Underw. Bull. Ill. State Lab. Nat. Hist. **2**: 92. 1884.—*Plate XVIII.*

*Sphagnoecetis Macounii* Aust. Bull. Torr. Bot. Club **3**: 13. 1872.

*Sphagnoecetis communis*, var. *tessellata* Berggr. Kongl. Sv. Vet. Akad. Handl. **13**$^7$: 101. 1875.

*Jungermannia tessellata* Berggr. *l. c.* 13$^8$: 43. 1875.

*Cephalozia* (*Odontoschisma*) *Austini* Pears. List Canad. Hepat. 10. 1890.

*Odontoschisma Sphagni*, var. *tessellatum* Kaalaas, Vidensk. Skrift. I. **1898**$^9$: 14.

*Odontoschisma tessellatum* C. Jensen, Meddel. om Grønland **15**: 369. *f. 1–4.* 1898.

Plants pale green or yellowish, rarely tinged with brown, growing in depressed mats or creeping among other bryophytes: stems sparingly and irregularly branched, 0.2$^{mm}$ in diameter, prostrate, ascending at the tips; flagella postical, with very minute and rudimentary leaves; vegetative and sexual branches varying from postical to lateral, but usually occupying the latter position; rhizoids scanty, borne either on the flagella or on the postical surface of the stem and leafy branches, never on the underleaves: leaves imbricated, strongly concave, broadly orbicular, 0.75$^{mm}$ long, 0.85$^{mm}$ wide, not margined, attached by an oblique line of insertion, neither dilated at the postical base nor decurrent antically, margin entire, apex varying from broadly rounded to truncate or slightly retuse, very rarely indistinctly bilobed: leaf cells 25$\mu$ in diameter at the margin of leaf, 28$\mu$ in the middle and at the base, with very large, occasionally confluent and rounded trigones; cell cavities stellate with narrow pits; cuticle very thick, smooth: underleaves varying from minute to rather large, reaching a maximum length of about 0.2$^{mm}$, when well developed ovate to oblong in shape, rounded, retuse or irregularly bilobed at the apex, margin entire, but bearing numerous slime-papillae: inflorescence dioicous: ♀ inflorescence borne on a short branch; involucral leaves (bracts and bracteoles practically indistinguishable) in three rows, leaves of innermost row slightly complicate, ovate, 1.4$^{mm}$ long, 0.75$^{mm}$ wide, bifid about one-fourth with narrow sharp-pointed lobes and sinus, margin subentire or bearing a few small and irregular lobe-like teeth, marginal papillae numerous, especially at the apices of the teeth; leaves of outermost row small and suborbicular, truncate at the apex or slightly bifid with a broad sinus, marginal papillae few, mostly at the base; leaves of middle row intermediate in character; perianth oblong in outline, contracted at the base and at the apex, 3.4$^{mm}$ long, 0.95$^{mm}$ wide, obtusely three-keeled, somewhat plicate in the upper part, mouth slightly and irregularly lobed, the divisions entire or very vaguely crenulate from projecting cells: ♂ inflorescence occupying a short branch; bracts in three or four pairs, complicate, slightly bifid or truncate, inflated near the antical base and commonly bearing a small inflexed tooth at about the middle of the antical margin; bracteoles similar to the underleaves; antheridia borne singly: capsule oval; spores brownish, minutely verruculose, 14$\mu$ in diameter; elaters 9$\mu$ in diameter, bispiral: gemmiparous branches long and worm-like, simple, terminating normal vegetative branches, prostrate or ascending; leaves in three equal ranks (the underleaves being similar to the side-leaves) subtransversely inserted, imbricated, concave, oblong, variously erose-dentate along margin in upper part and at apex; gemmae oval to pyriform, arising singly or in chains from the margin and outer surface of the leaves and finally from the stem-apex, one-celled or usually two-celled, with a thick outer wall and a thin transverse partition, occasionally mixed with slime-papillae.

On banks. GREENLAND: Claushavn (*Berggren*); Cape Stewart (*Hartz*); Hurry Inlet, Cape Franklin, Cape Mary (*Dusén*). YUKON: Dawson (*Williams*); Hunker Creek, Gold Run Creek (*Macoun*). ONTARIO: "25 miles north of Michepicoten and near Otter Head, Lake Superior" (*Macoun*), the type localities. MINNESOTA: near Grand Marais, north shore of Lake Superior (*Holzinger*). Also reported from Spitzbergen (*Berggren*) and from Norway (*Kaalaas, Jörgensen*).

EXSIC.: *Can. Hep.* 101 (as *Cephalozia Austini*).

2. **Odontoschisma Gibbsiae**, sp. nov.—*Plate XIX, figs. 29–34.* Plants yellowish green, more or less tinged with red or brown, growing in depressed mats or creeping among other bryophytes: stems sparingly and irregularly branched, $0.3^{mm}$ in diameter, prostrate, ascending at the tips; flagella postical or terminating leafy branches; vegetative branches varying from postical to lateral; rhizoids scanty: leaves imbricated, strongly concave, increasing in size from the base of a leafy axis, orbicular, $1^{mm}$ long, not bordered, attached by an oblique line of insertion, slightly decurrent antically and more or less dilated at postical base, arching to or beyond the middle of the axis, margin entire, apex rounded: leaf-cells $16 \times 23\mu$ at edge, $19\mu$ in diameter in the middle and $23\mu$ at the base, with very large and occasionally confluent rounded trigones; cell cavities stellate with distinct pits; pigmentation when present limited to the lining of the cavity, not affecting the limiting membrane of the pits nor the outer part of the very thick smooth or minutely verruculose cuticle: underleaves minute, except at the base of a branch, irregular in shape, sometimes vaguely bidentate: inflorescence unknown: gemmae and gemmiparous branches similar to those of *O. Macounii* but the latter with more loosely imbricated leaves.

On a log. BRITISH COLUMBIA: Port Renfrew, Vancouver Island (*Miss Gertrude Gibbs*), the type locality.

3. ODONTOSCHISMA DENUDATUM (Mart.) Dumort. Recueil d'Obs. sur les Jung. 19. 1835.—*Plate XIX, figs. 35–38.*

*Jungermannia scalaris*, var. *β denudata* Martius, Fl. Crypt. Erlangensis 183. 1817.

*Jungermannia denudata* Nees; Martius, *op. cit. praef.* p. xiv. 1817.

*Pleuroschisma* (*Odontoschisma*) *denudatum* Dumortier Syll. Jung. Eur. 69. 1831.

*Sphagnoecetis communis β macrior* Nees, G. L. & N. Syn. Hep. 149. 1845.

*Sphagnoecetis Huebneriana* Rabenhorst, Deutschlands Krypt.-Flora **2**: 338. 1848.

*Odontoschisma Huebnerianum* Aust. Hep. Bor.-Amer. 61b. 1873.

*Cephalozia* (*Odontoschisma*) *denudata* Spruce, On Cephalozia 61. 1882.

*Odontoschisma Sphagni β denudatum* Massal. & Carest. Nuovo Gior. Bot. Ital. **14**: 238. 1882.

*Odontoschisma Sphagni* var. *macrior* Meylan, Bull. de l'Herb. Boissier II. **1**: 629. 1901.

On rotten logs, more rarely on shaded banks. GREENLAND: Scoresby Sound (*Hartz*). NOVA SCOTIA: Pirate's Cove and Baddeck (*Macoun*). NEW BRUNSWICK: Campobello (*Farlow*). ONTARIO: Ottawa and Bellville, (*Macoun*). NEW HAMPSHIRE: Shelburne (*Farlow*); Franconia (*Mrs. Curtis*); Jackson (*Evans*). VERMONT: Mt. Mansfield and Lake Dunmore (*Farlow*). MASSACHUSETTS: New Bedford (*Ingraham*); Magnolia (*Farlow*). CONNECTICUT: Windsor, Salisbury and Hamden (*Evans*). NEW YORK: near Syracuse (*Underwood*). NEW JERSEY: Delaware Water Gap and Bergen (*Austin*); Atsion (*Evans*). DELAWARE: Newark (*Commons*). DISTRICT OF COLUMBIA (*Holzinger*). VIRGINIA: Marion (*Mrs. Britton* and *Miss Vail*). NORTH CAROLINA: Salem (*Schweinitz*). OHIO (*Sullivant*). TENNESSEE (*Ruth*). FLORIDA: Monticello (*Lighthipe*). ALABAMA: Mobile (*Mohr*); Citronville (*Baker*). LOUISIANA: Covington (*Langlois*). Widely distributed in Europe and in northern Asia: also reported from tropical America.

EXSIC.: *Musci Alleg.* 229 (as *Jungermannia Sphagni*, var. 2); *Hep. Bor. Amer.* 61b (as *Odontoschisma Huebnerianum*); *Hep. Amer.* 124; *Can. Hep.* 102 (as *Cephalozia Sphagni*), 105 (as *Cephalozia deundata*).

4. ODONTOSCHISMA SPHAGNI (Dicks.) Dumort. Recueil d'Obs. sur les Jung. 19. 1835.—*Plate XIX, figs. 39–41.*

*Jungermannia Sphagni* Dicks. Fasc. Pl. Crypt. Brit. 1:6. 1785.

*Pleuroschisma* (*Odontoschisma*) *Sphagni* Dumort. Syll. Jung. Eur. 68. 1831.

*Sphagnoecetis communis* α *vegetior* Nees, G. L. & N. Syn. Hep. 149. 1845.

*Odontoschisma Sphagni* var. *Europaea* Spruce, Journal of Botany **5**: 167. 1876.

*Cephalozia* (*Odontoschisma*) *Sphagni*, Spruce, On Cephalozia 60. 1882.

*Cephalozia Sphagni* var. *Europaea* Spruce, Hepaticae Amaz. et And. 401. 1885.

In bogs, creeping over *Sphagnum* or *Leucobryum*. NOVA SCOTIA: Louisburg (*Macoun*). Widely distributed in northern Europe. The species has also been reported, in North America, from Greenland (*Berggren*), from Miquelon Island (*Delamare*), and from various localities in the United States, but all the latter references are probably incorrect.

5. ODONTOSCHISMA PROSTRATUM (Swartz) Trevis. Mem. R. Ist. Lomb. III. 4:419. 1877.—*Plates XIX, XX, figs. 42–64.*

*Jungermannia prostrata* Swartz. Prodr. Fl. Ind. Occ. 142. 1788.

? *Sphagnoecetis prostrata* Nees; G. L. & N. Syn. Hep. 149. 1845.

*Pleuroschisma prostratum* Mitt., Challenger Rept. Bot. $1^2$: 92. 1884.

Plants pale green, often tinged with brownish, growing in depressed mats or creeping among mosses and other bog-plants:

stems sparingly and irregularly branched, $0.25^{mm}$ in diameter, prostrate with ascending tips; branches all postical; rhizoids scanty: leaves distant to loosely imbricated, plane or slightly concave, varying in shape from orbicular to oblong, $0.7–1.4^{mm}$ long, $0.75–1.3^{mm}$ wide, distinctly margined, attached by an oblique line of insertion, slightly decurrent antically but not dilated at postical base, margin entire, apex commonly rounded, sometimes truncate, emarginate or bilobed: median and basal leaf-cells $20\mu$ in diameter, thin-walled and with minute but distinct trigones; cell cavities polygonal with rounded angles; marginal cells $14 \times 23\mu$, forming one to four concentric rows and often arranged in radial rows as well, their walls more or less uniformly thickened with indistinct trigones; cuticle somewhat thickened, smooth or minutely verruculose: underleaves more or less persistent, linear to subulate in shape, $0.15^{mm}$ long, $0.05^{mm}$ wide, shortly bifid at the apex; slime papillae borne on the margin and more rarely on the postical surface, short-lived: inflorescence dioicous: ♀ inflorescence on a short branch; involucral leaves in about three rows, those of the innermost row $1^{mm}$ long, $0.5^{mm}$ wide, ovate, bifid about one-half with slender spreading acuminate lobes and narrow sinus, margin entire or with one or two slender lobe-like teeth below the middle; leaves of outermost row smaller and relatively broader, rounded or slightly bifid at the apex, margin entire; leaves of middle row intermediate in character; perianth linear-ovoid, $3^{mm}$ long, $0.9^{mm}$ wide, slightly contracted at the base and at the apex, obtusely three-keeled in lower part when young, terete when old, plicate in upper part, mouth irregularly lobed or cleft, the lobes subentire to short-setulose, the setae rarely more than one cell long: ♂ inflorescence occupying a short branch; bracts in about six pairs, complicate, shortly bifid with obtuse lobes and sinus, inflated near the antical base and commonly with a short and often inflexed tooth at about the middle of the antical margin; bracteoles larger than the ordinary underleaves, ovate, more or less distinctly bifid with subulate lobes; antheridia borne singly: capsule oval; spores brownish, $12\mu$ in diameter, minutely verruculose; elaters $9\mu$ in diameter, bispiral: gemmae wanting.

In bogs or swamps, more rarely on sandy banks or rocks. MASSACHUSETTS: Woods Hole (*Evans*). CONNECTICUT: New Haven (*Eaton*); North Branford (*Evans*). NEW YORK: Staten Island (*Underwood, Mrs. Britton, Howe*); Freeport, Long Island (*Howe*). NEW JERSEY: Delaware Water Gap and Closter (*Austin*); Locust and Highlands (*Miss Haynes*); Fort Lee (*Howe*); Avon (*Lloyd*); Atsion (*Evans*). DELAWARE: Wilmington and Newark (*Commons*). DISTRICT OF COLUMBIA (*Holzinger*). VIRGINIA: Nicks Creek, Marion, Dismal Swamp, and Virginia Beach (*Mrs. Britton* and *Miss Vail*). NORTH CAROLINA: Beaufort (*Johnson*). SOUTH CAROLINA: Summerville (*Miss Dubois*). GEORGIA: Tallulah Falls (*Underwood, Small*). FLORIDA: Amelia Island (*Eaton*); Grand Island, Lisbon, Eustis, and Blandton (*Underwood*); Port Orange and Lake City (*Straub*). ALABAMA: Mobile (*Mohr*). MISSISSIPPI: Bay St. Louis and Pass Christian (*Langlois*); Ocean Springs (*Seymour*). MISSOURI: Mine La Motte (*Russell*). ARKANSAS: Malvern (*Russell*). LOUISIANA: without definite locality (*Drummond*); Mandersville, Covington, St. Martinsville, and Opelousas (*Langlois*). Also reported from Jamaica (*Swartz*), the type-locality, from various other stations in tropical America and from Europe (see page 323).

EXSIC.: *Musc. Amer. St. Merid.* 161 (as *Jungermannia Sphagni*) *Musc. Alleg.* 228 (as *Jungermannia Sphagni*, var. 1); *Hep. Bor.-Amer.* 61 (as *Odontoschisma Sphagni*); *Hep. Amer.* 36 (also as *O. Sphagni*); C. Wright's *Hep. Cubenses*, without number (as *Sphagnoecetis prostrata*).

Very similar in appearance to *O. prostratum* are sterile specimens of *Jamesoniella autumnalis* (DC.) Steph. (=*Jungermannia Schraderi* Mart.), and the two species are often confused in herbaria, both being referred to *O. Sphagni*. *J. autumnalis* commonly grows on decayed logs, but is sometimes found on shaded banks or on rocks.. It has succubous undivided leaves and is of about the same size as *O. Sphagni*. It is, however, quite destitute of flagella; its leaves are not distinctly bordered, and its leaf-cells are slightly larger, averaging 21 μ in the middle of the leaf and 28 μ at the base. Of course, fruiting specimens of the *Jamesoniella* are very distinct, the perianth being terminal on a leading branch.

ODONTOSCHISMA PORTORICENSE (Hampe & Gottsche) Steph. Hedwigia, **27**: 296. 1888.—*Plate XX, figs. 65–74.*

*Sphagnoecetis Portoricensis* Hampe & Gottsche, Linnaea **25**: 343. 1852.

Plants yellowish green, growing in depressed mats: stems prostrate, sparingly and irregularly branched, 0.35$^{mm}$ in diameter;

leafy branches varying in position from postical to lateral, flagella postical or terminating leafy branches, sexual branches (so far as known) postical; rhizoids scanty: leaves imbricated, plane or slightly convex, more or less crispate, oblong to ligulate, on robust stems reaching a length of $2^{mm}$ and a width of $1^{mm}$, not margined, attached by an oblique line of insertion, slightly decurrent antically, more or less strongly dilated near the postical base, margin entire or irregularly sinuate, apex truncate or emarginate: leaf-cells averaging $23\,\mu$ in diameter at margin of leaf, $28\,\mu$ in the middle, and $32\,\mu$ at the base, with large, occasionally confluent, truncate or retuse trigones; cell cavities stellate with rather broad and truncate pits, cuticle thickened, smooth or minutely verruculose: underleaves minute, less than $0.1^{mm}$ long, ovate to broadly orbicular, apex commonly rounded; slime-papillae borne on the margin and on the postical surface, short-lived: inflorescence dioicous: ♀ inflorescence on a short branch; involucral leaves in about three pairs; leaves of innermost pair free or slightly connate at the base, ovate-oblong, $0.1^{mm}$ long, $0.4^{mm}$ wide, bifid about one-third with narrow acute spreading lobes and narrow sinus, margin entire or irregularly subcrenulate, sometimes with one or more lobe-like teeth at about the middle of the sides; remaining involucral leaves shorter and relatively broader, those of the outermost row orbicular, shortly bifid, with acute tooth-like lobes; perianth linear in outline, $3^{mm}$ long, $0.8^{mm}$ wide, slightly contracted at the base and apex, terete (when old) in lower part, plicate in upper part, mouth irregularly lobed or cleft, the divisions ciliate with cilia one to five cells long: remaining parts not seen.

PORTO RICO (*Schwanecke*), the type locality. CUBA (*Wright*).

EXSIC.: C. Wright's *Hep. Cubenses*, without number (under a manuscript name of Gottsche).

The type-specimen of *O. Portoricense* in the herbarium of the British Museum is a little less robust than some of the Cuban specimens distributed by Wright. It agrees, however, very closely with other specimens in Wright's collection, and the latter are connected by a series of intermediate forms with the robust specimens. There seems to be no reason, therefore, for considering the Porto Rican and Cuban plants distinct.

There is no danger of confusing this very peculiar plant with any of our northern species of Odontoschisma. It differs from them, not only in its greater robustness, but also in its oblong to ligulate leaves with their edges parallel or nearly so except near the base. Other differences have already been indicated in discussing its relationship with *Anomoclada mucosa.*

In the preparation of this paper I have received valuable assistance not only from the botanists already mentioned but more especially from Professor L. M. Underwood, Professor W. G. Farlow, Dr. M. A. Howe, and Mr. W. R. Maxon. Through the kindness of these gentlemen I have been allowed access to the valuable herbaria under their charge and have also been provided with material for study from their private collections.

YALE UNIVERSITY.

## EXPLANATION OF PLATES XVIII–XX.

The figures were drawn by the writer and prepared for reproduction by Miss Edna L. Hyatt.

### *PLATE XVIII.*

FIGS. 1–28. *Odontoschisma Macounii* (Aust.) Underw.

FIG. 1. Part of a plant bearing a lateral branch with perianth, antical view. × 20.

FIG. 2. Part of stem, postical view. × 20.

FIG. 3. Male inflorescence, antical view. × 45.

FIG. 4. Longitudinal section through female branch and young sporophyte, showing also the calyptra, two unfertilized archegonia, several slime-secreting hairs, the perianth and three perichaetial leaves; somewhat diagrammatic. × 45.

FIG. 5. Median leaf-cells, surface-view. × 400.

FIG. 6. The same, cross-section. × 280.

FIG. 7. Marginal leaf-cells. × 280.

FIGS. 8, 9. Young underleaves. × 280.

FIGS. 10–12. More mature underleaves. × 280.

FIG. 13. Cells from margin of a well developed underleaf. × 280.

FIGS. 14–16. Perichaetial bracts and bracteole, innermost row. × 20.

FIGS. 17–19. The same, second row. × 20.

FIGS. 20–22. The same, third row. × 20.

FIG. 23. Cells from middle of perianth. × 280.

FIG. 24. Cells from mouth of perianth. × 280.

FIGS. 25–27. Perigonial bracts. × 45.

FIG. 28. Gemmae. × 400.

Figs. 9, 11 and 12 were drawn from Minnesota specimens collected by Holzinger; the remaining figures were all drawn from the Yukon specimens collected by Macoun.

## *PLATE XIX.*

### FIGS. 29–34. *Odontoschisma Gibbsiae* Evans.

FIG. 29. Part of stem, gemmiparous and with three-ranked leaves above. × 18.

FIG. 30. Part of stem, postical view. × 18.

FIG. 31. Median leaf-cells. × 350.

FIG. 32. Marginal leaf-cells. × 250.

FIG. 33. Young underleaf. × 250.

FIG. 34. More mature underleaf. × 250.

The figures were all drawn from the type specimens.

### FIGS. 35–38. *Odontoschisma denudatum* (Mart.) Dumort.

FIG. 35. Median leaf-cells. × 350.

FIG. 36. Marginal leaf-cells. × 250.

FIG. 37. Young underleaf. × 250.

FIG. 38. More mature underleaf. × 250.

The figures were drawn from Connecticut specimens collected by the writer.

### FIGS. 39–41. *Odontoschisma Sphagni* (Dicks.) Dumort.

FIG. 39. Median leaf-cells. × 350.

FIG. 40. Marginal leaf-cells. × 350.

FIG. 41. Underleaf, antical view, not showing the slime-papillae on the postical surface. × 250.

The figures were drawn from specimens distributed in Gottsche and Rabenhorst's *Hep. Eur.* 399.

### FIGS. 42–54. *Odontoschisma prostratum* (Swartz) Trevis.

FIG. 42. Part of a plant bearing a postical branch with perianth and a postical sterile branch. × 18.

FIG. 43. Part of stem, antical view. × 18.

FIG. 44. Part of stem, lateral view, showing flagella. × 18.

FIG. 45. Male inflorescence, antical view. × 40.

FIGS. 46–48. Perichaetial bracts and bracteole, innermost row. × 18.

FIGS. 49–51. The same, second row. × 18.

FIGS. 52–54. The same, third row. × 18.

### *PLATE XX.*

FIGS. 55–64. *Odontoschisma prostratum* (Swartz) Trevis.

FIGS. 55, 56. Median leaf-cells. × 350.

FIGS. 57, 58. Marginal leaf-cells. × 250.

FIG. 59. Young underleaf. × 250.

FIGS. 60–62. More mature underleaves. × 250.

FIG. 63. Cells from mouth of perianth. × 250.

FIG. 64. Perigonial bracteole. × 250.

Figs. 56, 58, 61 and 62 were drawn from Cuban specimens distributed by Wright; the remaining figures were drawn from Connecticut specimens collected by the writer.

FIGS. 65–74. *Odontoschisma Portoricense* (Hampe & Gottsche) Steph.

FIG. 65. Part of stem with lateral branch, antical view. × 18.

FIG. 66. Part of stem, postical view. × 18.

FIG. 67. Female branch with perianth. × 18.

FIG. 68. Median leaf-cells. × 350.

FIG. 69. Marginal leaf-cells. × 250.

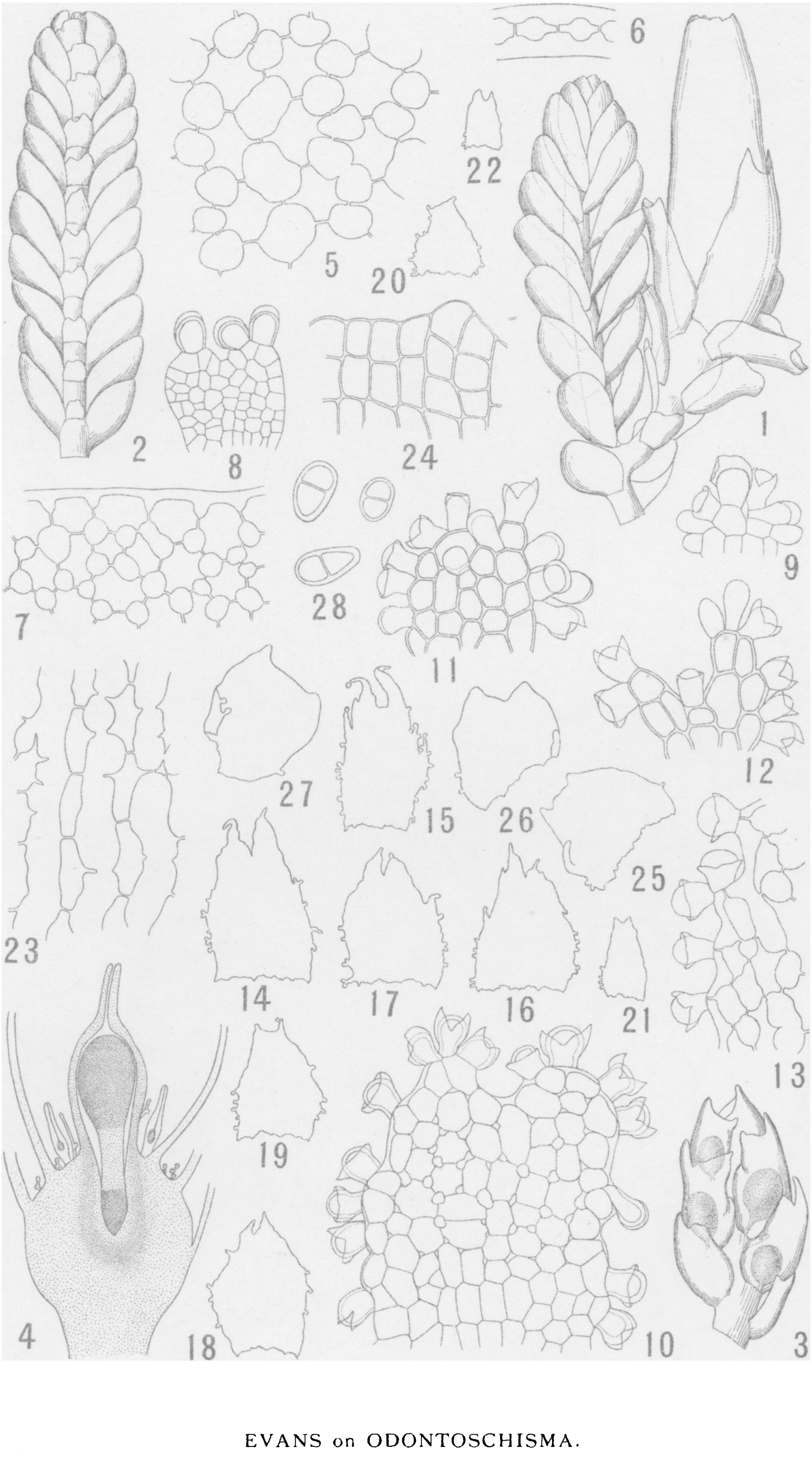
FIG. 70. Underleaf. × 250.

FIGS. 71, 72. Innermost bracts and bracteole from the same involucre. × 24.

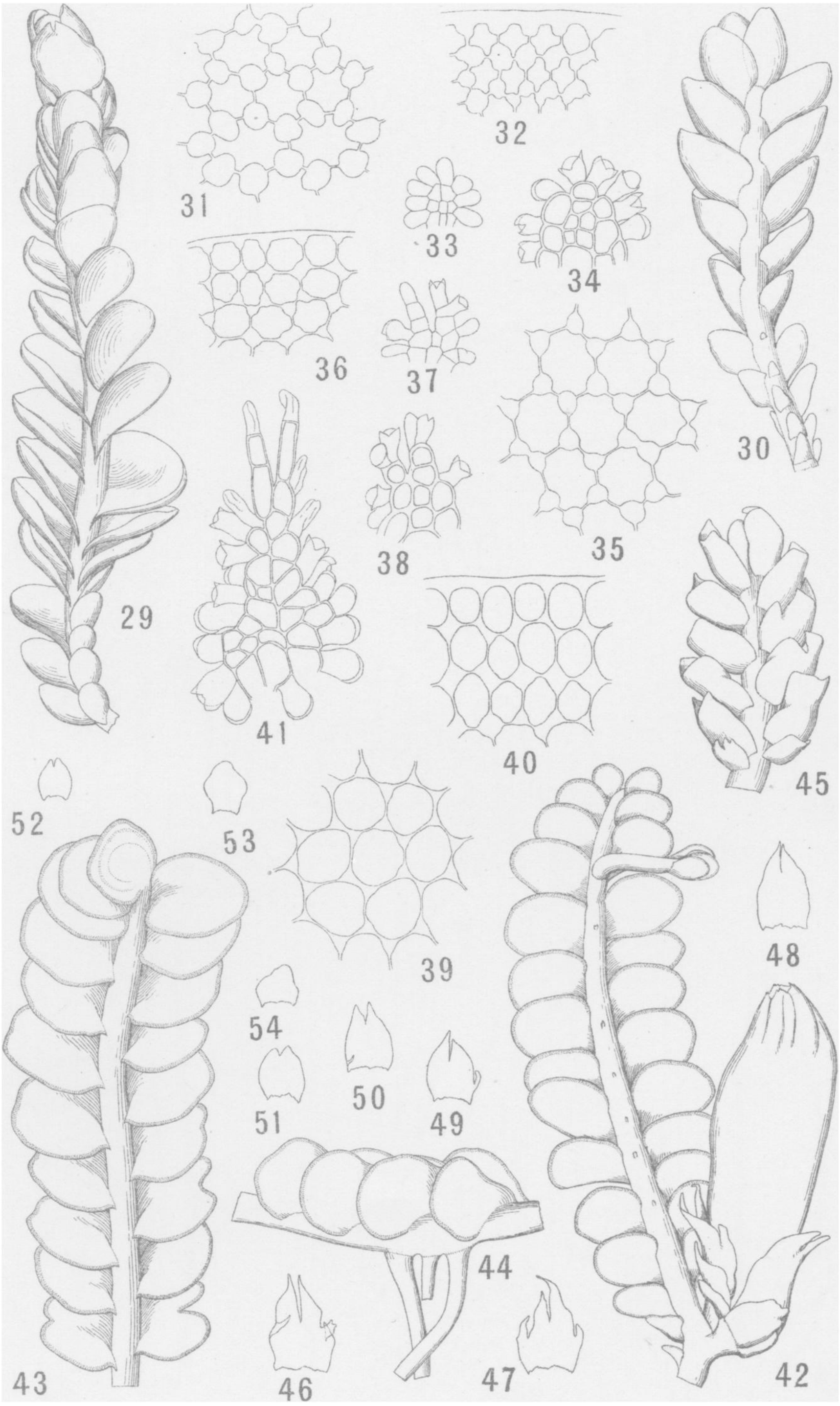
FIG. 73. Innermost bract from another involucre. × 24.

FIG. 74. Cells from mouth of perianth. × 250.

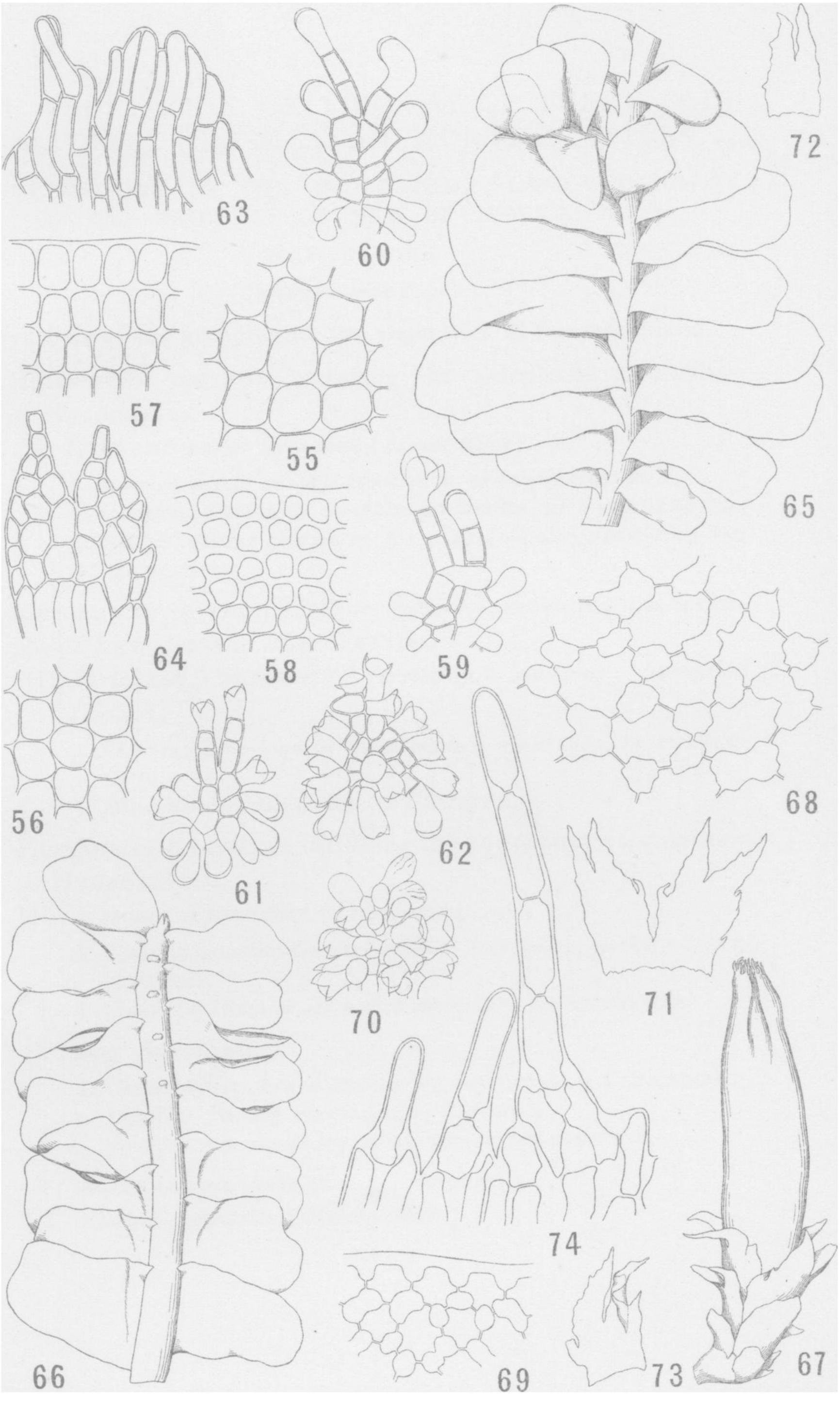
The figures were all drawn from the specimens distributed in C. Wright's *Hepaticae Cubenses.*



EVANS on ODONTOSCHISMA.



EVANS on ODONTOSCHISMA.



EVANS on ODONTOSCHISMA.